Altering Reservoir Wettability to Improve Production from Single Wells

DE-FC26-04NT15527

Goal

The goal of the project is to develop a surfactant soak technique to improve oil recovery by increasing the water-wettability of less than water-wet formations.

Performers

Correlations Company
Socorro, NM

Encore Acquisition Company
Fort Worth, TX

ConocoPhillips
Houston, TX

University of Wyoming
Laramie, WY

TIORCO, Inc.
Denver, CO

Gel Technologies Corp.
Midland, TX

Texland Petroleum, Inc.
Fort Worth, TX

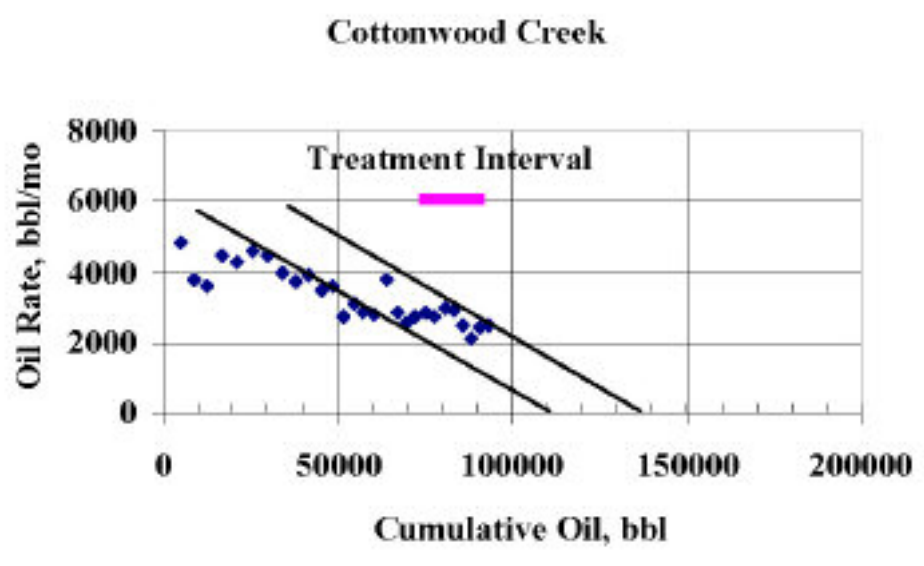
Range Resources Corporation
Ft. Worth, TX

Yates Petroleum, Inc.
Artesia, NM

Results

Technology developed for the Phosphoria formation in Wyoming is being adapted to the San Andres formation in the Permian Basin. Laboratory techniques developed during the course of an SBIR (Small Business Research Innovation) project that focused on the Phosphoria formation have also been extended to include the San Andres formation. Artificial intelligence (AI) correlations developed during the SBIR project were used to design surfactant soak treatments in the San Andres formation of the Fuhrman-Masho field near Andres, TX. AI techniques are being developed to establish baseline production trends in order to evaluate San Andres formation surfactant soak treatments in conjunction with the water-frac stimulation process.

Static imbibition tests with and without surfactant were completed with cores and fluids from the Cedar Creek anticline. The results indicate that a field test maybe warranted.



Summary of surfactant soak treatment results from 22 of 23 wells tested.

Benefits

Low-cost surfactant soak stimulation treatments will prolong the life of marginally economic wells in oil-wet reservoirs that contain about 22 percent of the Nation's domestic original-oil-in-place. Most of such reservoirs are oil-wet, heterogeneous, and naturally fractured, and are therefore ideal candidates for the surfactant soak process. An estimated 100,000 of the Nation's 500,000 domestic producing oil wells could benefit from surfactant soak technology.

Background

The project is the outgrowth of laboratory and field work done to stimulate oil production from the Phosphoria formation in the Cottonwood Creek field. The low-volume oil wells produce from a fractured, oil-wet carbonate reservoir in Wyoming. Imbibition testing of reservoir cores and fluids in the laboratory suggested the technique would work in the field.

Summary

The rate vs. cumulative chart suggests that the experimental field treatments produced about 25,000 bbl of incremental oil at a cost of $168,000. Of course, not all treatments performed equally. The patterns observed in the gamma ray log and the quantity of surfactant used with the incremental oil produced were correlated using AI. The neural network correlation of the standard deviation in the gamma ray log and the prior oil-producing rate was used to design surfactant treatments for the San Andres formation.

The highlights of the project are as follows:

- Laboratory results indicate that the San Andres formation in the Permian Basin is an excellent candidate for enhanced oil recovery via the surfactant soak process.
- Correlations developed in the Phosphoria formation are being used to design surfactant soak treatments in the San Andres formation.
- Water-frac results in a tight San Andres oil reservoir were evaluated using AI. The results will be used to analyze water-frac results plus surfactant in the same field.
- Three San Andres surfactant soak treatments were approved operating company management.

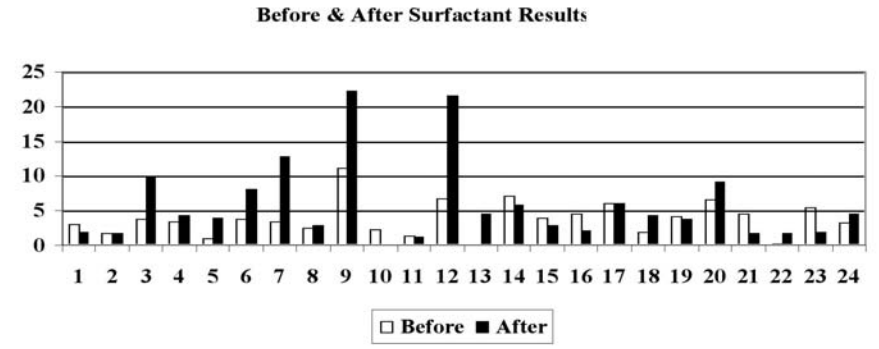
Current Status (June 2006)

Surfactant soaks field experiments are expected to be completed this summer (2006) in the Fuhrman-Masho (San Andres) pool in west Texas. Laboratory tests do not support a test of the surfactant soak process in the Eagle Creek field. During May 2006, high-temperature imbibition tests were run with Stoney Mountain, Red River, and Interlake cores

and fluids at ConocoPhillips Reservoir Mechanisms Section high-temperature laboratory facilities in Bartlesville, OK. Laboratory work with Arbuckle reservoir cores and fluids is expected to commence during the third quarter of 2006. If supported by laboratory results, field tests will follow.

Funding

This project was awarded under DOE's Oil Exploration and Production solicitation DE-PS26-04NT15450-0.



Distribution of surfactant treatment results.

Publications

Two papers were presented at a professional meeting and two peer-reviewed publications were accepted for publication in international journals.

Weiss, W.W., Xie, X., Weiss, J.W., Subramaniam, V., Taylor, A. and Edens, F., Artificial Intelligence Used to Evaluate 23 Single-Well Surfactant Soak Treatments, SPE 89457, presented at the 14th SPE/DOE Symposium on Improved Oil Recovery, Tulsa, OK, April 17-21, 2004.

Xie, X., Weiss, W.W., Tong, T., and Morrow, N.R., Improved Recovery from Carbonate Reservoirs by Chemical Stimulation, SPE 89424 presented at the 14th SPE/DOE Symposium on Improved Oil Recovery, Tulsa, OK, April 17-21, 2004.

Weiss, W.W., Weiss, J.W., Subramaniam, V., and Xie, X., AI Applied to Evaluate Waterflood Response, Gas Behind Pipe, and Imbibition Stimulation Treatments, Journal of Petroleum Science and Engineering, Vol. 49, Issues 3-4, December 15, 2005, Pages 110-121.

Weiss, W.W., Xie, X., Weiss, J.W., Subramanian, V., Taylor, A., and Edens, F., Artificial Intelligence Used to Evaluate 23 Single-Well Surfactant Soak Treatments, SPE Reservoir Evaluation & Engineering, June 2006 (in press).

Project Start: October 1, 2004
Project End: September 30, 2006

Anticipated DOE Contribution: $799,747
Performer Contribution: $698,000 (47 percent of total)

Contact Information

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